

to generate a running summation of the received signals. In general, the output of the accumulator 660 is generally similar to a first order approximation to an integral over the period of time that the accumulator operates. Thus, the accumulator 660, upon receipt of a number, stores the number. Then, upon receipt of another number, the accumulator 660
5 adds the first number to the second number and stores the result. The process continues in this manner. In one embodiment the accumulator comprises a summing operation and a register to store the accumulating result.

The output of the cross correlation process is an estimate of the impulse response. This is a time domain signal. Transforming the output into the frequency domain
10 provides the transfer function. There are a number of ways to transform the signal into the frequency domain, one being a DFT, another being an FFT. The output of the cross correlation comprises an estimate of the impulse response or channel response. Transforming this signal into the frequency domain yields the frequency spectrum, including all channel effects, of the sequence signal transmitted over the line.

15 One example embodiment of a cross correlation device is shown in Figure 7. Figure 7 illustrates block diagram of a correlation unit configured to correlate a received signal with a signal $C(n)$. An input 704 connects to a multiplier 708. A second input 712 provides a second signal to the multiplier 708. The output of the correlator connects to a summing junction 718, which has an output 720.

20 The received sequence signal is provided on input 704 to the multiplier unit 708 while a sequence signal $C(n)$, that is generally identical to the sequence

signal transmitted on the channel, is provided on the second input 712. These sequence signals are multiplied together on a value by value basis over time. The output of the multiplier 708 is summed, over time, in the summing junction 718 and provided on the output 720. The correlation system provides an output
5 signal with a peak at the point when the signals align, i.e. correlate. A noticeable peak at the point of correlation indicates a sequence with good correlation properties. One or more such points of correlation may indicate that the signal is a wake-up signal.

The accumulator or summing junction 718 comprises a device configured to
10 generate a running summation of the received signals. In general, the output of the summing junction 718 is generally similar to a first order approximation of an integral over the period of time that the system operates. Thus, the summing junction 718, upon receipt of a number, stores the number. Then, upon receipt of another number, the summing junction 718 adds the first number to the second number and stores the result.
15 The process continues in this manner. In one embodiment, the summing junction 718 comprises one or more registers to store the accumulating result. The output of the correlation process is an estimate of the impulse response of the channel. This is a time domain signal.

Another example embodiment of the cross correlation is based on frequency
20 domain processing. The cross correlation can be implemented in the frequency domain by multiplying together the frequency domain representation of the received signal and

the reference signal. The reference signal may be the discrete Fourier transform (DFT) of the transmit sequence. When periodic sequences are used, the frequency domain representation can be constructed by using a DFT of the same length as the period of the signal. If the receive signal consists of multiple periods, then the noise characteristics of the correlated signal can be improved by appropriately summing up multiple periods, either before or after taking the DFT of the received signal. For non-periodic signals or signals with long periods, it may be appropriate to compute the cross correlation in the frequency domain using the overlap-add or overlap-save methods. If the cross correlation is computed in the frequency domain, it may be appropriate to convert it back to the time domain for further time domain processing.

Figure 8A and 8B, which illustrates example plots of a sequence signal and the effect of correlation, are helpful in describing the advantages gained by the invention with regard to noise. Figure 8A illustrates a plot of a sequence signal 800 in relation to a vertical axis 802 representing magnitude and a horizontal axis 804 representing frequency. An undesirable noise component 810 resides between frequencies f_1 and f_2 . If a single pulse signal is transmitted, the noise that will be received with the signal will disrupt analysis or detection, especially if the noise resides at a frequency that coincides with the frequency of the pulse.

In reference to Figure 8B showing a plot of the correlated signal 820 and the noise 822 that is part of the correlated signal after correlation in relation to magnitude on the vertical axis 802 and time on the horizontal axis 830. During the correlation process, the